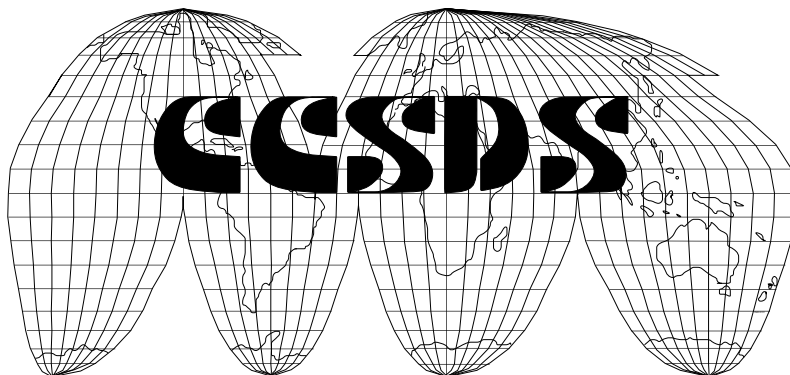# Consultative Committee for Space Data Systems

REPORT CONCERNING SPACE
DATA SYSTEMS STANDARDS

CROSS SUPPORT CONCEPT
PART 1
SPACE LINK EXTENSION SERVICES

CCSDS 910.3-G-1

GREEN BOOK

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FOREWORD

This document is a technical Report for use in developing Space Link Extension (SLE) service documentation and has been prepared by the Consultative Committee for Space Data Systems (CCSDS). The Cross Support Concept described herein is intended for spacecraft-to-ground data communication within missions that are cross-supported between Agencies of the CCSDS.

This Report establishes a common framework and provides a common basis for the development of SLE services. It allows the development of compatible derived Standards for the SLE services that are within their cognizance. Derived Agency Standards may implement only a subset of the optional features allowed by the Cross Support Recommendations.

Through the process of normal evolution, it is expected that expansion, deletion, or modification to this document may occur. This Report is therefore subject to CCSDS document management and change control procedures, which are defined in Reference [1].

DOCUMENT CONTROL

Document	Title	Date	Status and Substantive Changes
CCSDS 910.3-G-1	Report Concerning Space Data Systems Standards: Cross Support Concept—Part 1: Space Link Extension Services	May 1995	Original Issue

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1 INTRODUCTION

1.1 PURPOSE

The purpose of this Report is to present the cross-support concept for CCSDS Space Link Extension (SLE) services. It identifies the functional components of the ground-resident portion of a space data system and defines the interface points where agency interoperations may occur. This Report summarizes the technical considerations for all cross support of CCSDS-compliant space data systems.

This cross-support concept applies to all space data systems developed by participating CCSDS Space Agencies but is focused on those missions which will involve cross support between multiple space agencies.

This Report establishes a foundation on which SLE services may be unambiguously defined. It presents the environment of a space data system, highlighting some of the aspects that are unique to such a system. In doing that, it identifies the domain that the SLE covers on the ground. It describes all the interface types that are involved as well as identifies the functional "building blocks" of the system.   The interfaces involved with Service Management are also included. With this foundation, SLE services may be specified without confusion in subsequent CCSDS documents. Scenarios are presented to show that the foundation is valid even against current systems.

1.2 SCOPE

The scope of this Report is the identification of the concepts and terms which establish a common basis for the development of CCSDS Recommendations for SLE services specifications. In defining these concepts and terms the following assumptions are made:

  a) the context is that of a single space mission;

  b) within this space mission a single spacecraft is considered;

  c) this spacecraft's telemetry and telecommand is compliant with CCSDS Advanced Orbiting Systems (AOS), Packet Telemetry (TM), and Telecommand (TC) Recommendations (references [2]–[7]); and

  d) all ground end-users (i.e., data sinks or sources) are affiliated with a single mission-management entity.

1.3   APPLICABILITY

This Report applies to the development of Agency Standards related to the Space Link Extension domain of space data systems, particularly those which are, or may be, involved in cross support. This Report identifies the functional components of the SLE System. It is not a specification of any particular implementation.

1.4   RATIONALE

The primary goal of CCSDS is to increase the level of interoperability among agencies. This Report furthers that goal by establishing the basis for a set of SLE services to be used in the area where most cross-support activity occurs: between the tracking stations or ground data handling systems of various agencies and the mission-specific components of a mission ground system.

1.5   DOCUMENT STRUCTURE

This Report is organized as follows:

Section 1   This section provides purpose, scope, applicability, and rationale of this Report and lists the definitions, conventions, and references used throughout the Report.

Section 2   This section contains an overview of the cross-support environment in which SLE services must be provided. It provides the context of cross support, presents the cross-support documentation structure, and shows how this Report fits into that framework. It expands on the scope of this Report to provide an overview of the document.

Section 3   This section presents the Service Concept itself. It identifies the functional composition and provides examples of actual cross-support implementations.

Section 4   This section presents cross-support scenarios and the functional distribution of SLE Complexes.

Section 5   This section presents the high-level Management concept. It covers the System Life Cycle and associated Goals and Objectives as well as management concepts in providing SLE services.

Annex A   This annex contains a list of accepted terminology to be used in describing cross support.

Annex B   This annex defines the acronyms used in the text of this Report.

1.6   DEFINITIONS

The definitions provided below are those needed for understanding this Report as a whole. Many other terms are defined throughout this Report.

Return Data. For the purposes of this Report, return data is all data that is sent from the space element to the ground element (e.g., telemetry).

Forward Data. For the purposes of this Report, forward data is all data that is sent from the ground element to the space element (e.g., telecommand).

1.7   REFERENCES

The following documents contain provisions which, through reference in this text, constitute provisions of this Report. At the time of publication, the editions indicated were valid. All documents are subject to revisions, and users of this Report are encouraged to investigate the possibility of applying the most recent editions of the documents indicated below. The CCSDS Secretariat maintains a register of currently valid CCSDS documents.

[1]   *Procedures Manual for the Consultative Committee for Space Data Systems*. CCSDS A00.0-Y-6. Yellow Book. Issue 6. Washington, D.C.: CCSDS, May 1994.

[2]   *Packet Telemetry*. Recommendation for Space Data Systems Standards, CCSDS 102.0-B-3. Blue Book. Issue 3. Washington, D.C.: CCSDS, November 1992.

[3]   *Telemetry Channel Coding*. Recommendation for Space Data Systems Standards, CCSDS 101.0-B-3. Blue Book. Issue 3. Washington, D.C.: CCSDS, May 1992.

[4]   *Advanced Orbiting Systems, Networks and Data Links: Architectural Specification*. Recommendation for Space Data Systems Standards, CCSDS 701.0-B-2. Blue Book. Issue 2. Washington, D.C.: CCSDS, November 1992.

[5]   *Telecommand Part 1 — Channel Service*. Recommendation for Space Data Systems Standards, CCSDS 201.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, January 1987.

[6]   *Telecommand Part 2 — Data Routing Service*. Recommendation for Space Data Systems Standards, CCSDS 202.0-B-2. Blue Book. Issue 2. Washington, D.C.: CCSDS, November 1992.

[7]   *Telecommand Part 3 — Data Management Service*. Recommendation for Space Data Systems Standards, CCSDS 203.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, January 1987.

[8]   *CCSDS Global Spacecraft Identification Field Code Assignment Control Procedures*. Recommendation for Space Data Systems Standards, CCSDS 320.0-B-1. Blue Book. Issue 1. Washington, D.C.: CCSDS, October 1993.

[9]   *CCSDS Publications Manual*. CCSDS A20.0-Y-1. Yellow Book. Issue 1. Washington, D.C.: CCSDS, May 1994.

[10]   *Standard Terminology, Conventions, and Methodology (TCM) for Defining Data Services*. Report Concerning Space Data Systems Standards, CCSDS 910.2-G-1. Green Book. Issue 1. Washington, D.C.: CCSDS, November 1994.

[11]   *Space Link Extension — Cross Support Reference Model*. Draft Recommendation for Space Data Systems Standards, CCSDS 910.4-R-1. Red Book. Issue 1. Washington, D.C.: CCSDS, November 1995.

[12]   *Information Technology—Text Communication—Message-Oriented Text Interchange Systems (MOTIS)—Part 3: Abstract Service Definition Conventions*. International Standard, ISO/IEC 10021-3:1990 (E). 1st ed. Geneva: ISO, 1990. As updated by Technical Corrigendum 1, ISO/IEC 10021-3:1990/Cor. 1:1992 (E). Geneva: ISO, 1992.

[13]   *Information Technology—Open Systems Interconnection—Specification of Abstract Syntax Notation One (ASN.1)*. International Standard, ISO 8824. 2nd ed. Geneva: ISO, 1990.

2   OVERVIEW

The Consultative Committee for Space Data Systems (CCSDS) is an international committee that discusses common problems relative to the development of space data systems. CCSDS performs end-to-end systems analyses and adopts or develops standard approaches for solving these routine problems. After these approaches are officially accepted by the CCSDS member agencies, they are issued as CCSDS Recommendations.

As CCSDS Recommendations are adopted and implemented by space agencies, compatible support capabilities are developed in those agencies. It is then possible for agencies to share, more easily and with less cost, the resources which have been established to acquire data from remote sensors; to transport this information to designated destinations; to process their data for various purposes; and to store the data for future reuse.

The term "cross support" is applied when one agency uses part of another agency's data system resources to complement its own system. Cross support can be beneficial for many reasons. The objective of CCSDS activity is to facilitate cross support, thereby maximizing the performance and cost benefits to be gained.

The charter of CCSDS is to facilitate interoperability between space agencies through the development of data handling techniques for spacecraft operations, space research, and space science applications. There are substantial costs associated with the implementation and operation of the data systems to meet these requirements. A significant portion of these costs is associated with frequent design and development of customized systems. As the demands placed upon such data and information systems increase, system cost-reduction measures assume greater importance. Development of standard methods of performing routine tasks will reduce the costs.

In addition to the nominal execution, cross support provides a firm basis for emergency operations. Emergency operations include both spacecraft emergencies or ground facility problems which result in the need for additional support. Emergency Operations are not treated separately in this Report since they are considered to be specific use of cross support.

2.1   CONTEXT

The space data system has two primary elements; a space element, which includes applications and services resident in space, and a ground element, which includes applications and services resident on the ground. The space element and ground element are linked via the Space Link services. These services are described in CCSDS Space Link Services Recommendations (references [2]–[7]), collectively referred to as the CCSDS Space Link Recommendations. The Space Link services will be extended across the ground using the complementary Space Link Extension services. Extension is accomplished over distance, in time, and by adding information (i.e., annotation). This includes some services normally provided in ground stations, operation control centers, and data processing facilities. Figure 2-1 illustrates the scope of these services.
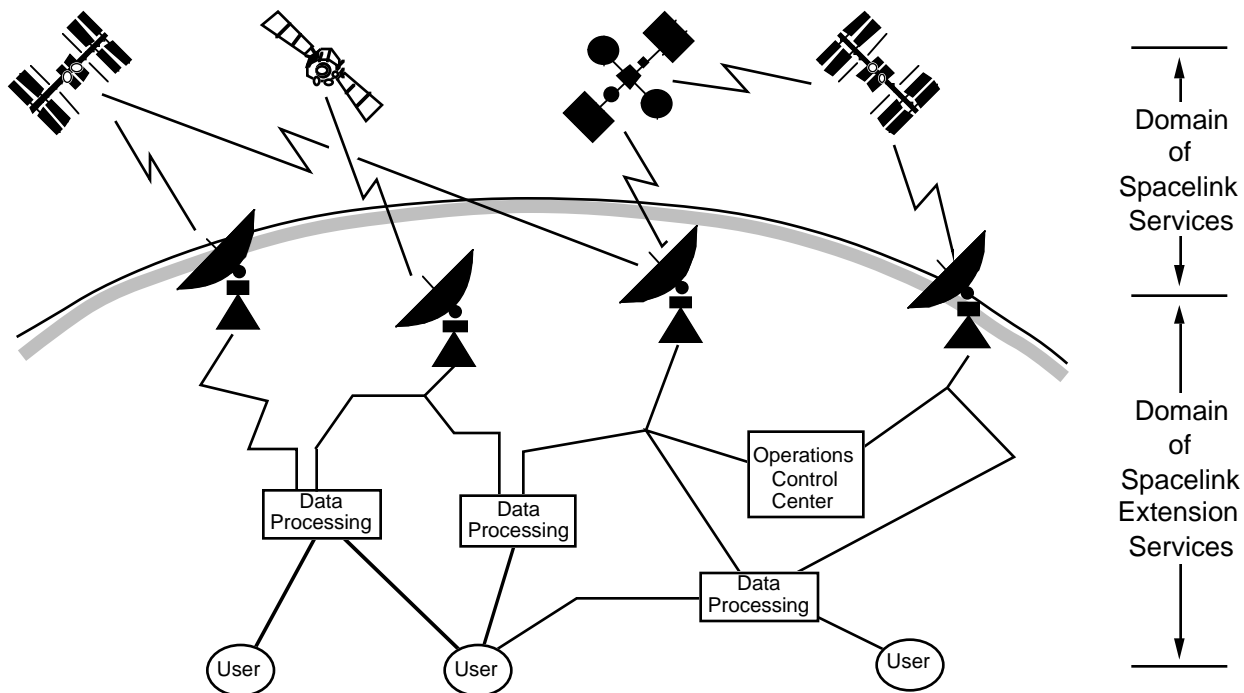
Figure 2-1: Domains of Space Link and Space Link Extension Services

2.2   CROSS SUPPORT DOCUMENTATION

Cross-support services is a generic term that encompasses all services that can be provided by one agency to support another agency in operating a spacecraft. On the ground, cross support services are of three kinds:

– SLE services, extending CCSDS Space Link services as defined in CCSDS Space Link Recommendations (references [2]–[7]);

– ground communications services, providing ground communications support, e.g., to relay operational data;

– Ground Domain services, covering all services which handle data related to spacecraft operations but not directly mappable to Space Link data structures defined in CCSDS Space Link Recommendations. Examples of ground domain services are tracking a spacecraft, exchanging spacecraft data bases, and mission planning.

This Report establishes the cross support concept for extending Space Link services across the ground. These capabilities are provided by SLE services.

The cross support documentation is divided into three reports:

– this Report, Part 1 of the Cross Support Concept, addresses SLE services;

–   Part 2 of the Cross Support Concept will establish the cross-support concept for the use of communication services underlying the ground element;

–   Part 3 of the Cross Support Concept will address Ground Domain services.

This document provides the information background for the definition of the SLE services documents. The document tree is shown in figure 2-2. The suite of Cross Support documents includes the following:

–   *Space Link Extension — Cross Support Reference Model*: a draft Recommendation, which introduces the SLE Reference Model (reference [11]);

–   SLE Service Management specification: a Recommendation (to be published), which defines the management interface required for the provision of one or more SLE services;

–   SLE service specifications: Recommendations (to be published). There will be one SLE service specification per SLE service.

This Report

Cross Support
Reference Model
Part 1
SLE Services

Cross Support
Concept
Part 1
SLE Services

SLE Service
Package
Management
Specification

SLE Transfer
Services

Cross Support SLE
Service
Specification
Return All Frames

Return VC Frames

Return Space Packet

Cross Support SLE
Service Specification
Forward CLTU

Forward TC Frames
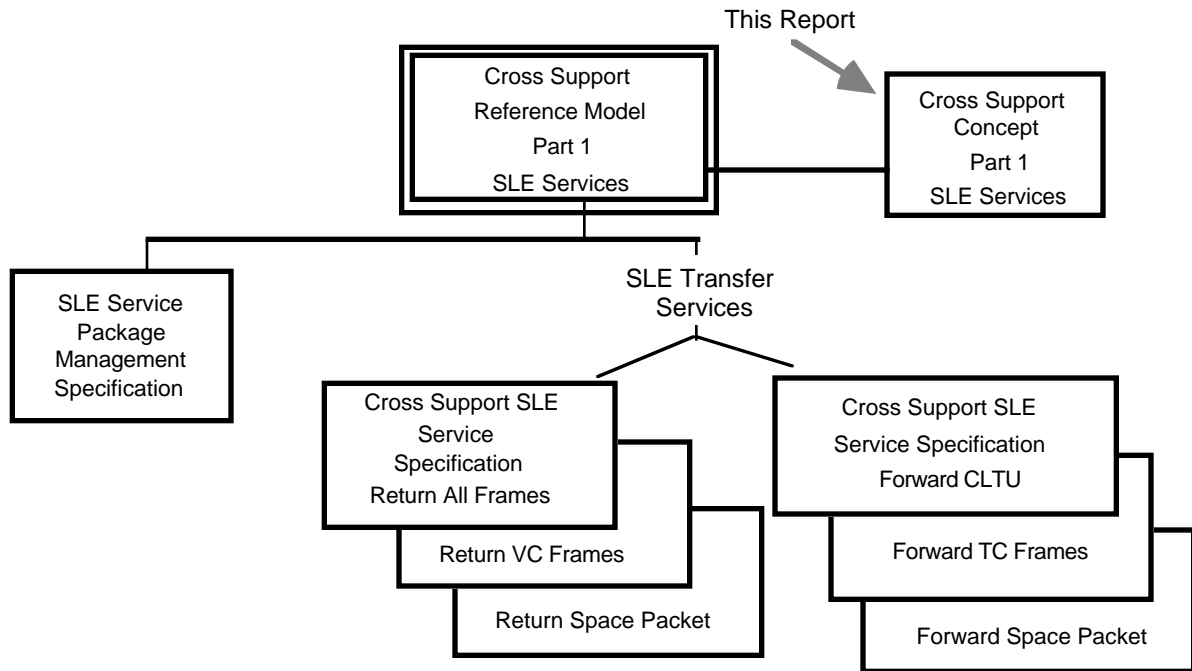
Forward Space Packet

Figure 2-2: SLE Services Documentation Tree

The Terminology, Conventions, and Methodology Report (reference [10]) contains the methodologies agreed upon for representing abstract services. It also contains a set of agreed-upon references. These references and methodology are utilized in this Report.

3   CROSS SUPPORT ENVIRONMENT

A space mission is an undertaking to explore fields of interest through the use of spacecraft. One or more spacecraft may be involved in a particular mission. Each space mission involves significant functionality, both in space and on the ground. This functionality may be implemented by a single space agency, or it may be divided among multiple space agencies. Cross support exists when multiple space agencies are involved in providing space mission functionality.

The data services provided between the spacecraft and the ground are services built upon the services defined in CCSDS Recommendations for conventional telecommand systems, packet telemetry systems, and advanced orbiting systems (references [2]–[7]). These services are collectively called the CCSDS Space Link services in this Report.

The CCSDS Space Link Recommendations define services for the transfer of data across the Space Link. However, space data systems generally require additional features on the ground in order to use the Space Link services to support mission requirements. These additional features include the ability to extend the Space Link services beyond the immediate endpoints of the Space/Ground Link and are provided by SLE services. The Space Link is extended from systems on board the spacecraft, attached to onboard local-area networks, to systems on the ground, attached to terrestrial wide-area networks. This extension is illustrated in figure 3-1. SLE services also provide the ability to hold data at one or more intermediate points.

This section introduces the environment in which cross support will be accomplished.

3.1   SPACE MISSION DATA SYSTEM

A Space Mission Data System, as illustrated in figure 3-1, is the set of onboard and ground data systems that support a mission. It consists of a space element and a ground element. Payload equipment and/or astronauts/cosmonauts are carried on board the spacecraft to perform exploration tasks. A spacecraft also contains various subsystems that control and monitor the operation of the spacecraft. Collectively, the payloads, the astronauts/cosmonauts (including electronic systems they use), and the spacecraft operations subsystems constitute the space element. The ground data systems constitute the ground element. The space element and ground element exchange return and forward data.
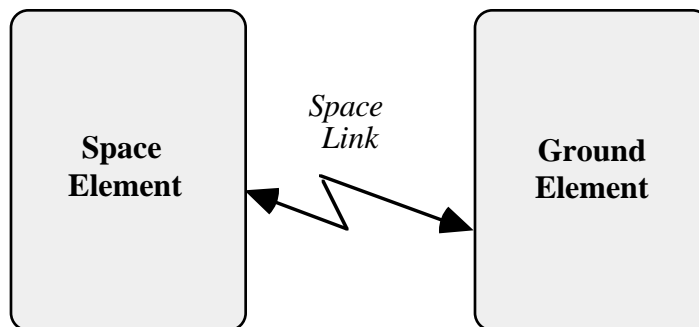

Figure 3-1: Space Mission Data System

The space element acts as a source of return data and as a sink for forward data. In this Report, the space element represents a single spacecraft and comprises the platform and all payloads/instruments of this spacecraft. The space vehicles in a multi-spacecraft mission are treated as individual space elements. Platform and payloads/instruments are considered here only for their capability of generating or receiving data. Processing they perform on this data is not within the scope of this Report.

3.2 SPACE LINK EXTENSION SYSTEM ENVIRONMENT

The ground element of a space mission data system includes an SLE System and a Mission Data Operation System (MDOS). It may also contain other components, but these are not within the scope of this Report. Figure 3-2 illustrates these components.
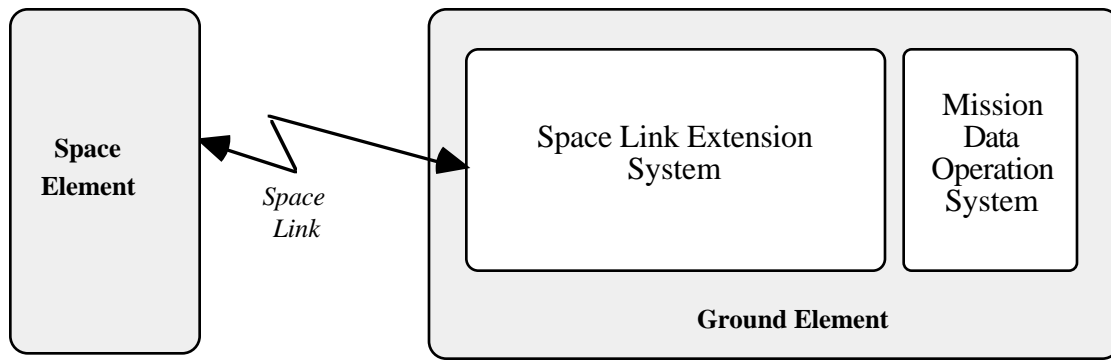
Figure 3-2: Ground Element of a Space Mission Data System

The SLE System extends the transfer and delivery of forward and return data between a Space Link ground termination point and the MDOS. In the context of a mission, the SLE System is managed by the MDOS.

The complete set of SLE services is identified later in this Report. A particular mission may use all or a subset of the SLE services. In providing SLE services, the SLE System performs:

– RF modulation/demodulation at the ground termination of the Space/Ground Link;

– ground termination of the Space Link protocols (that is, the protocols for the CCSDS Space Link services) used by the mission;

– adding of value-added information (called annotation) to Space Link service data;

– terrestrial networking among the ground elements that host the ground applications;

– interface to ground-side Space Link protocol processing and ground-side RF modulation/demodulation functions.

The MDOS is dedicated to a space mission. It acts as a source of forward data and as a sink of return data. The MDOS may not be the ultimate source of forward data or sink of return data on the ground element, but from the perspective of this Report it acts as if it were these sources and sinks.

3.3   SPACE LINK EXTENSION SERVICE CONCEPT

The Space Link protocols have been defined by CCSDS Panel 1 and are described in CCSDS Packet Telemetry, Telecommand, and AOS Recommendations (references [2]–[7]). They are unique to the space mission environment and provide the customized services and data communications protocols necessary to perform space/ground and space/space communications. A key feature of the Space Link protocols is the concept of "Space Data Channels." Single Physical Channels can be divided into several separate logical data channels. Each Space Data Channel of the Space Link Subnetwork (SLS) may support different service requirements.

Each of these Space Data Channels can carry higher-level data units, such as Virtual Channel Data Units (VCDUs) or Packets, each separately identified. In other words, they carry a virtual stream of Space Link data units, referred to as Space Data Channels, which are the same type and have a single, unique identification. Different combinations of data units can be nested in these Space Data Channels. Not all combinations are valid. The Space Link Recommendations define which combinations can be used. Different missions may select different combinations.

The SLE services are a set of services that extend the CCSDS Space Link services, providing access to the ground termination of Space Link services from a remote ground-based system. The SLE services correspond to the various Space Link services.

Space Link Extension (SLE) services comprise:

– SLE Transfer Services, which are concerned with the ground part of the data transfer. This transfer is either within the ground data system or between the ground data system and the ground data sinks.

– SLE Management Services, which control the scheduling and provision of SLE Transfer Services by ground systems.

SLE services extend the Space Link services across the ground system.   This "extension" of Space Link services has three aspects:

– **Extension over Distance**.   Space Link protocol processing may be performed in multiple locations that are geographically separated from the place where the RF signal is received.

– **Extension in Information**. Information, identified at the time of receipt, indicating the conditions at the time of receipt, is added to the Space Link data.

–   **Extension in Time**. The SLE System also extends space link services in time, by allowing space link data to be transferred through the ground element and the Space Link at different times.

The following subsections show how Space Link services can be extended across the ground to a user.

3.3.1   EXTENSION IN INFORMATION

There is some information that is not known prior to receipt of the Space Link data and must be added by the service facility receiving the Space Link data unit. For example, information that might be added onto return link data may include:

–   time when the Space Link data was received at the RF service facility;

–   identification of the ground location where the data was received;

–   quality of the data unit, indicating whether the data unit is correct and complete according to the criteria available; and

–   sequence quality, indicating whether the data unit is a direct successor to the previous instance of the data unit (i.e., an indication of missing data).

CCSDS Space Link protocols utilize out-of-band signaling for delivery of management information in order to save communications bandwidth and to minimize processing. Examples of additional information that may be added are:

–   data type, indicating whether the data was stored temporarily on board the spacecraft;

–   operations mode, indicating the source of the data (e.g., spacecraft, simulator, test, etc.) and delivery option (online, offline/rate buffered, etc.); and

–   signaling of data format parameters, such as frame size or presence or absence of an insert.

Extension in information is illustrated in figure 3-3a. This figure shows the simple case. The Space Link data is terminated at a ground station where annotation is determined and attached to the data stream. It assumes that all SLE processing has been done at the ground station and that fully processed space packets may be delivered directly to the user, after the annotation is attached.
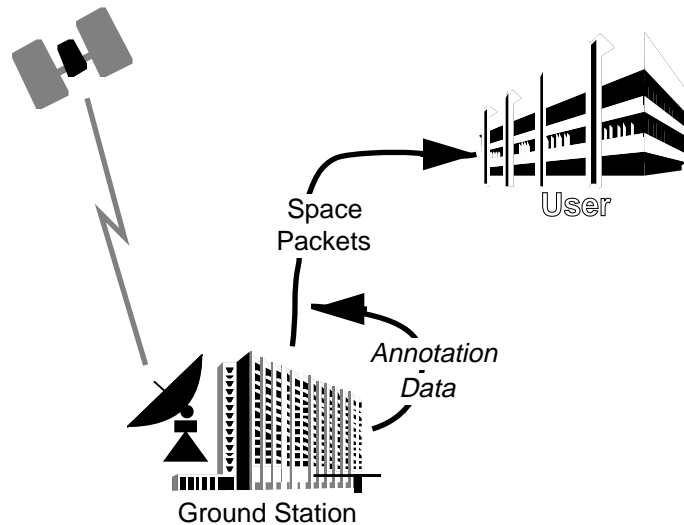
Figure 3-3a: Example of Space Link Extension (Information)

The concept of annotation for the forward link has not yet been so well defined as it has for the return link. However, the annotation data that has been applied on ground will have to be removed before transmittal over the Space Link. Examples of information that might be added to forward link data include:

–   spacecraft identification;

–   time scheduled for transmission;

–   maximum delay tolerance;

–   frame length; and

–   coding parameters.

3.3.2   EXTENSION OVER DISTANCE

The cross-support environment allows SLE services to be implemented by multiple service provider facilities, each performing a portion of the necessary processing. Each SLE service provider facility delivers Space Link data either to a mission ground segment or to another service provider facility. In the second case, the facilities may be separated geographically.

In an effort to minimize processing and communications overhead, Space Link protocols frequently are not layered as rigorously as ground protocols. For example, a single data field may be reused for several purposes, or the value of a data field located in one layer may be needed for processing at higher layers. Such information might be lost if processing is performed at different locations. For example, the CCSDS Application Identifier (APID),

located in the CCSDS Packet, is unique within a spacecraft but is not necessarily unique across missions. The Spacecraft Identification (SCID) field, located in the frame or VCDU, serves to qualify the APID. This qualifying information would be lost if VCDUs were processed at a different location from the location of packet processing, unless provisions were made to send the SCID information.

Information that would normally be available if all processing were completed at the same location may not be available when facilities are separated geographically. Each facility must send sufficient information to the next facility to allow the processing to be completed.

In addition to information associated with Space Link data, information is also needed that is not associated with an individual data unit. An example is "loss of frame synchronization." Such information about each SLE service must be defined as part of its service specification.

Figure 3-3b shows a situation that might arise when all SLE processing is not done at the ground station when the signal is terminated. In this case, the ground station provides the stream of frames extracted from the Space Link signal (shown as "all frames" in the figure), along with associated annotation, to a geographically separate data processing facility which produces Space Packets and sends them directly to the user facility.
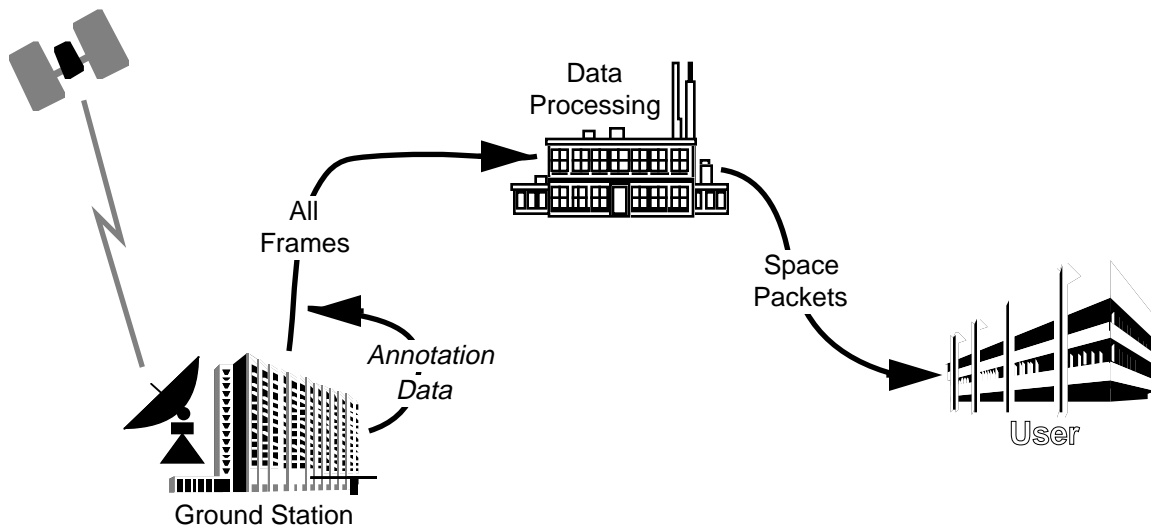
Figure 3-3b: Example of Space Link Extension (Distance)

3.3.3   EXTENSION IN TIME

The SLE System also extends Space Link services in time, by making Space Link data available at a time after the data units are first received on the ground by adding information to ensure that the data is useful at this later time and by temporarily storing the data until it can be transferred to the user. The difference in data delivery time can vary widely. Delivery may be delayed very briefly, such as by a reduced communication rate on the ground, or it may be delayed greatly, such as by temporary storage and later forwarding.

Figure 3-3c shows all three aspects of Space Link service extension. The signal is terminated at the ground station, where annotation data is attached to the data stream. This ground station provides a stream of frames extracted from the Space Link signal (shown as "all frames" in the figure) to a remote data processing facility. This facility performs the next layer of SLE processing and provides a stream of VC Frames to yet another data processing facility. The path is shown as a shaded and broken line to indicate great geographic distance, perhaps to a different continent. At the second facility the data might be stored temporarily. At a later date, the SLE processing is completed and space packets are produced and sent directly to the user facility.

3.4   SPACE LINK EXTENSION SYSTEM DESCRIPTION

The SLE System provides SLE services to the users in a space mission. SLE services can be considered from both a functional and a physical viewpoint.

From the functional point of view, the processing required to provide SLE services is accomplished by a set of fundamental building blocks called Functional Groups (FGs). These FGs are defined to align with the Space Link protocol layer structure.
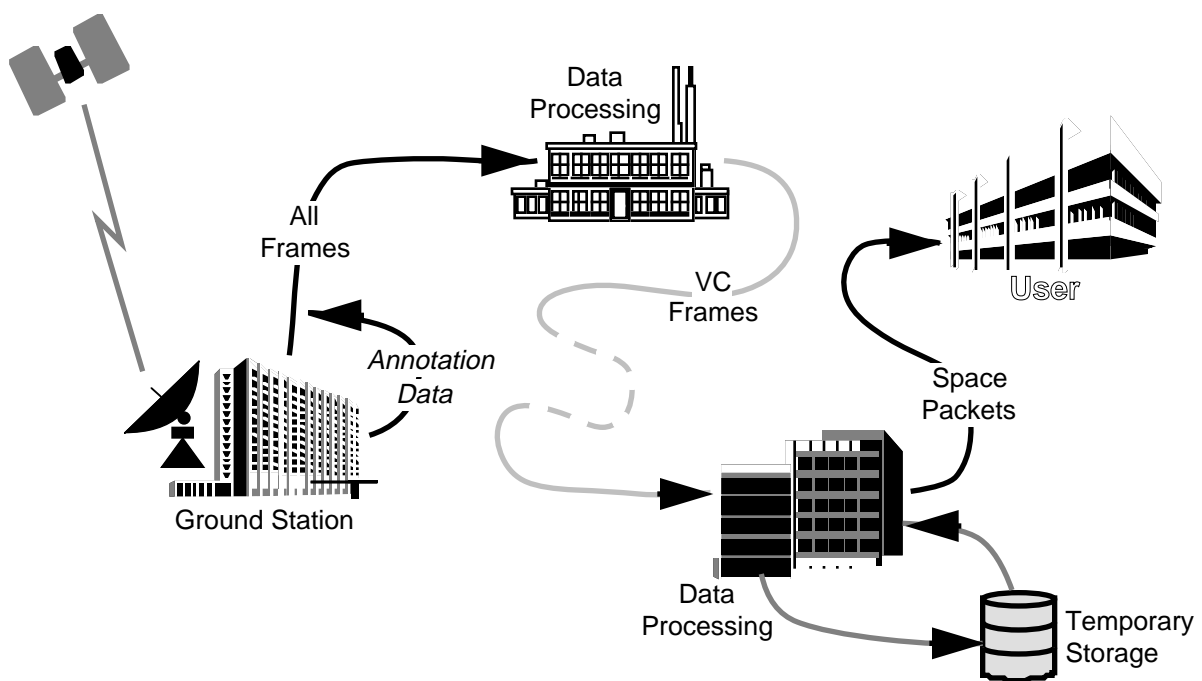

Figure 3-3c: Example of Space Link Extension (Time)

From the physical point of view, these FGs can be implemented in various configurations as described in the previous subsection. The physical facilities that implement a set of functional groups are called SLE Complexes.

SLE services are separated into three categories:

- – return SLE services;

- – forward AOS SLE services; and

- – forward telecommand SLE services.

The following subsections provide an explanation of the specific SLE services, the SLE FGs that perform the functionality, and the SLE Complexes that provide the services.

3.4.1   FUNCTIONAL GROUPS

The SLE System is composed of multiple Functional Groups (FGs). An FG is the fundamental building block of an SLE service; it is not decomposed further. FGs are derived from the layered functionality specified in the Space Link protocols.

FGs fall into three categories:

- – Return SLE services:

  - • Return Space Link Processing FG;
  - • Return Frame Processing FG;
  - • Return Frame Data Extraction FG;

- – Forward AOS SLE services:

  - • Forward AOS VC Data Insertion FG;
  - • Forward AOS Space Link Processing FG;

- – Forward Telecommand SLE services:

  - • Forward TC VC Data Insert FG;
  - • Forward CLTU Generation FG;
  - • Forward TC Space Link Processing FG.

3.4.2   SLE SERVICES

The SLE services are a set of services that extend the CCSDS SLS services, providing access to the ground termination of Space Link services from a remote ground-based system.

The following sections describe these SLE service categories in terms of the FGs identified above. Each of the service categories is treated separately. For each service category, a diagram is provided that shows the FGs along with the SLE services that are provided by each. Real implementations of an FG may provide all or only a subset of the services that are defined for that FG.

Figure 3-4a shows the FGs involved in performing Return Link SLE services and identifies the services that are provided by each. All of the services shown are available for cross support, including those between the FGs.
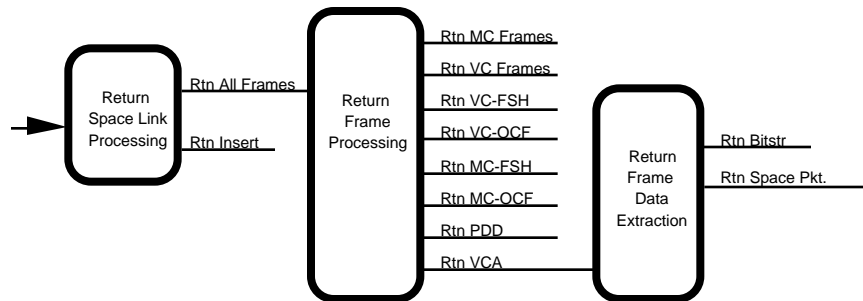
Figure 3-4a: Return SLE Functional Groups and Services

Some SLE services are inter-related in ways such that it is impossible to distribute them across different FGs. For example, processing for the Return Insert service must be merged in the same FG with processing for the Return All Frames service.

Figure 3-4b shows the FGs involved in performing Forward Link AOS SLE services and identifies the services that are provided by each. All of the services shown are available for cross support, including those between the FGs.

Figure 3-4b: Forward AOS SLE Functional Groups and Services

Figure 3-4c shows the FGs involved in Forward Link Telecommand SLE services and identifies the services that are provided by each. All of the services shown are available for cross support, including those between the FGs.
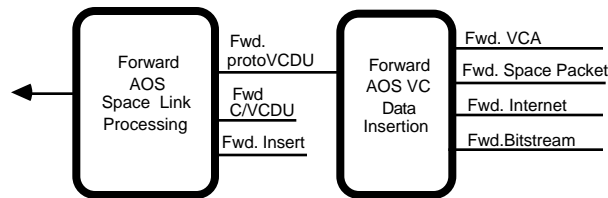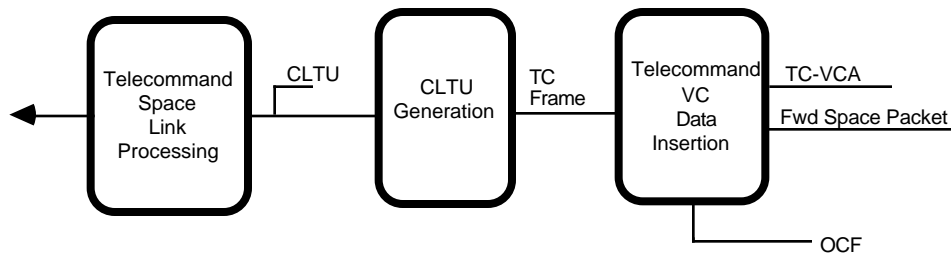
Figure 3-4c: Forward Telecommand SLE Functional Groups and Services

Each FG may provide the following types of functionality:

–   functionality associated with processing the data from one service level to the next; data products and control must be received from preceding FGs or a function in the spacecraft or mission domain;

–   supplier functionality associated with supplying the service to a user; data products and control must be provided to the next FG or a function in the spacecraft or mission domain.

The SLE Reference Model Recommendation (reference [11]) provides more detail concerning the functionality of the FGs and services. The applicable SLE service specifications define the relationship between services implemented and functionality required to provide those services.

3.4.3   SLE COMPLEXES

The SLE Complex is a logical grouping of FGs that collectively perform a subset of the entire SLE service functionality. FGs are implemented in various configurations by different agencies. All FGs in an SLE Complex are under the authority of a single Complex Manager. Figure 3-5 shows an example of an SLE Complex consisting of four FGs managed by a single Complex Manager.
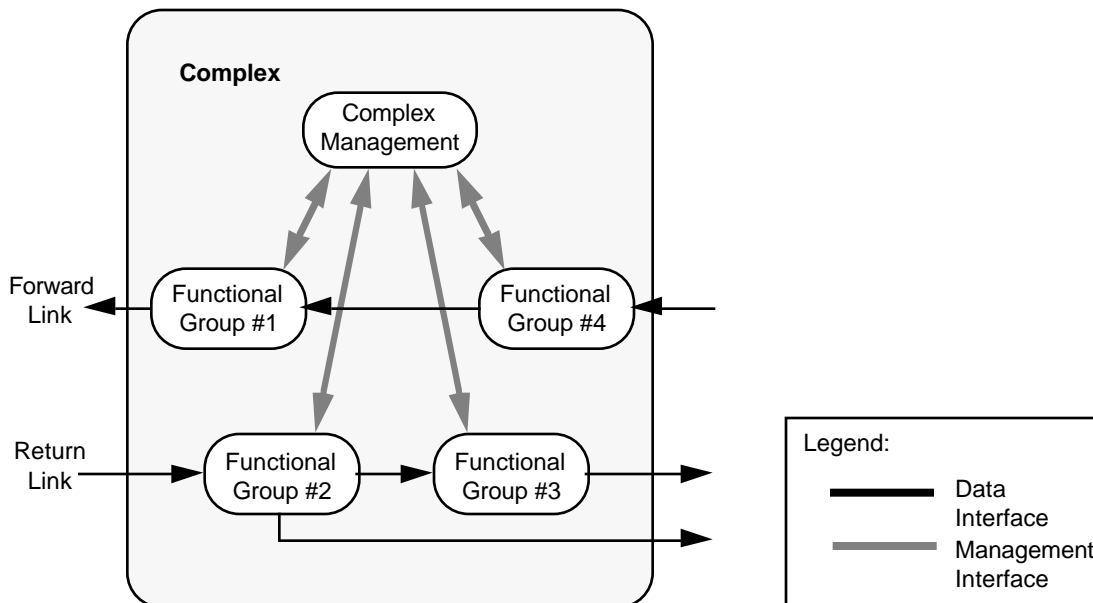

Figure 3-5: Example—Functional Group Configuration within a Complex

SLE Systems are often made up of several SLE Complexes that interoperate to provide SLE services to a space mission. These physical systems may be independently operated by different agencies. Each Complex must implement all functions required to provide SLE services.   However, all functions are not necessarily exposed outside the Complex. Individual functions of an FG cannot be distributed across multiple SLE Complexes. All functions of an FG must be implemented within a single SLE Complex.

From a mission cross-support view, the SLE System is composed of one or more SLE Complexes as illustrated in figure 3-6.

The interfaces between SLE Complexes must conform to the interfaces defined for SLE services. This limits the possible combinations for distributing SLE service functions to a finite set, because there is only a fixed number of possible transitions from one service level to the next.
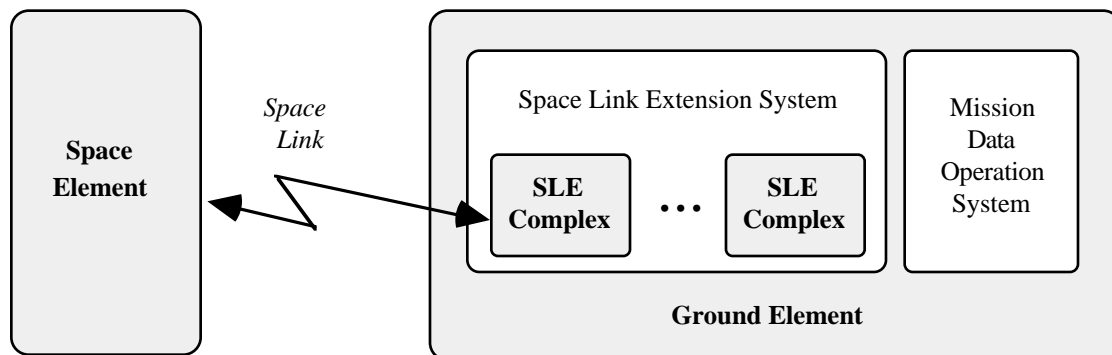
Figure 3-6: SLE Complexes

The management of an SLE service is distributed between SLE Complexes and the MDOS. The management component of an SLE Complex is called Complex Management. The component of Mission Management responsible for SLE services is called Utilization Management. Service Management is accomplished through the management of the functions performed by the individual SLE Complexes that provide the SLE services.

If a service is provided by multiple SLE Complexes, Utilization Management coordinates with Complex Management in the multiple SLE Complexes to provide the services required by the mission. Utilization Management must also coordinate and resolve conflict among multiple service users. Complex Management represents the functions performed within the SLE Complex in a standard way, in terms of the SLE services provided by the Complex (not in terms of the equipment used to provide those services), and without SLE Complex-internal details. Complex Management provides the interface that hides the complexity of the SLE Complex. These concepts are illustrated in figure 3-7.

Figure 3-7: SLE Complex/MDOS Interfaces

4   CROSS SUPPORT SCENARIOS

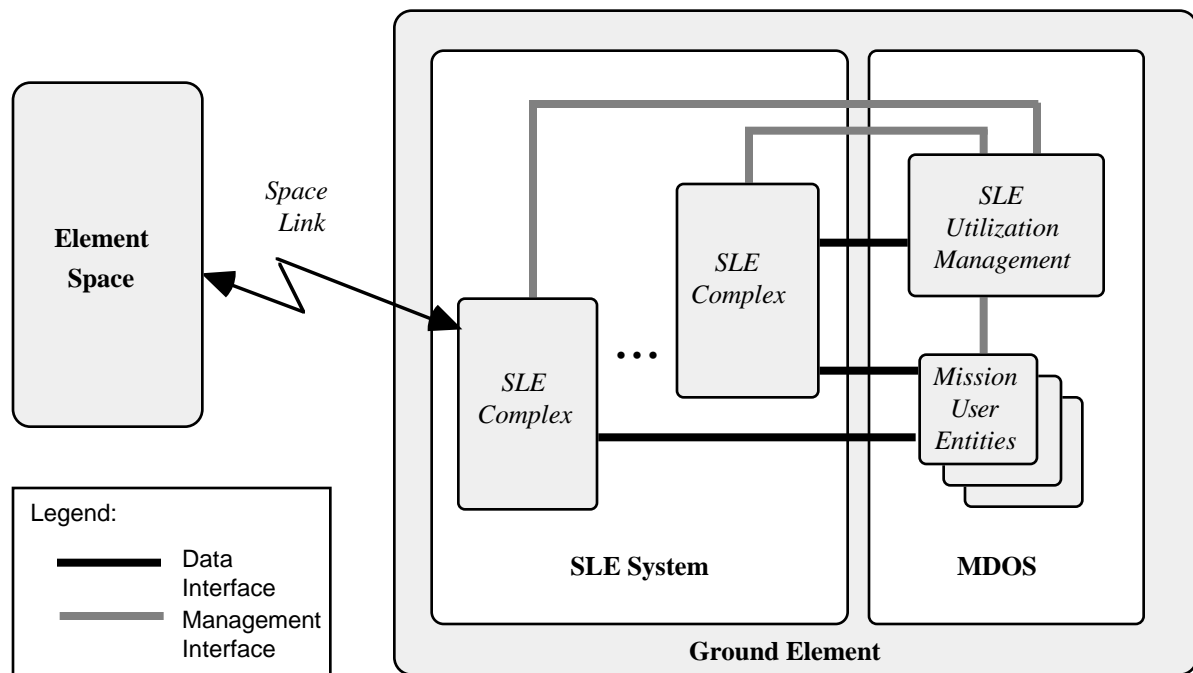Cross support may occur between SLE Complexes within the SLE System and/or between the SLE System and an application in the spacecraft or mission domain. The SLE System builds on the Space Link standards by standardizing the SLE and Service Management protocols and services. Such standardization allows a mission to interface with the SLE System, concatenating SLE services by interconnecting SLE Complexes within the SLE System, no matter how or where the services are implemented.

Implementation of cross support is the responsibility of each agency. Therefore, the groupings of FGs into SLE Complexes may be unique to an agency. However, it should be noted that there is a limited number of rational groupings which may be selected by an agency. Inputs to and outputs from each FG are all potential cross-support points; however, it depends on the selected implementation.

The following subsections illustrate the SLE service concept for providing cross support by presenting a set of scenarios. First, a functional view is used to illustrate how different agencies have implemented their ground systems with different configurations. Then, a more physical viewpoint is used in depicting scenarios that are very similar to cross support that has already occurred or is planned.

4.1   FUNCTIONAL DISTRIBUTION OF COMPLEXES

When discussing cross support, a functional rather than a physical view is needed. There are cases where different agencies use the same word for a facility but mean different functions. For example, in figure 4-1, "ground station" contains an extensive processing capability; the control center distributes files of user data as well as performs forward link functions. In figure 4-2, "ground station" has a limited capability; return link processing, offline processing, and command control are performed at different facilities.
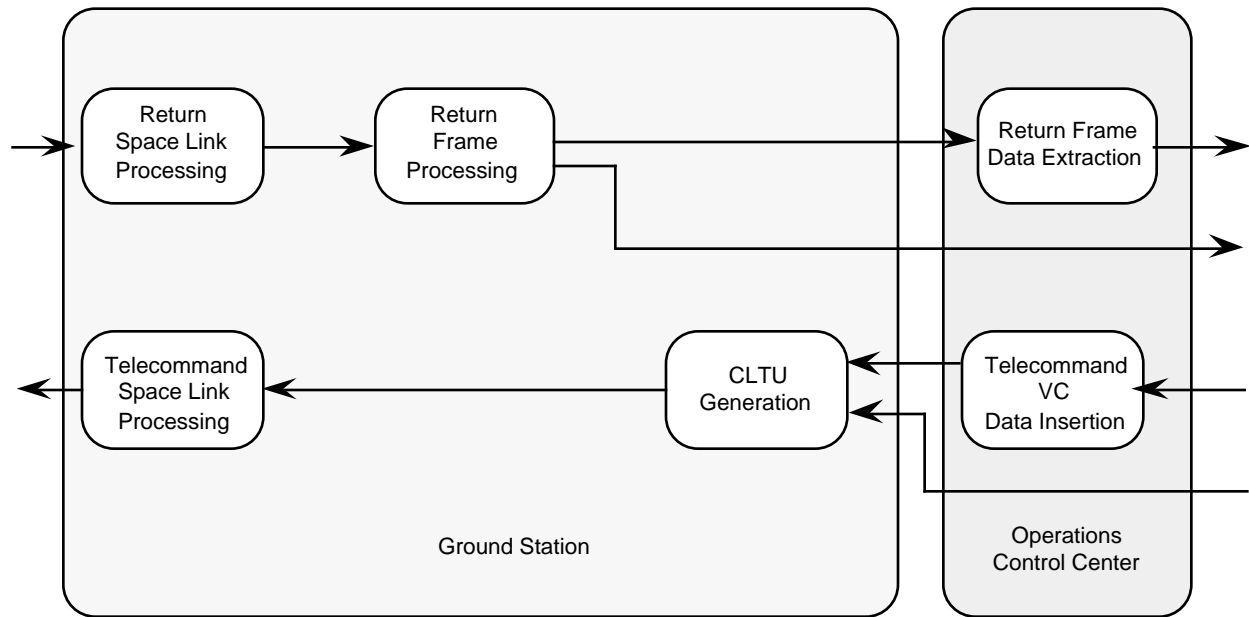
Figure 4-1: Example of Ground Station with Extensive Capability
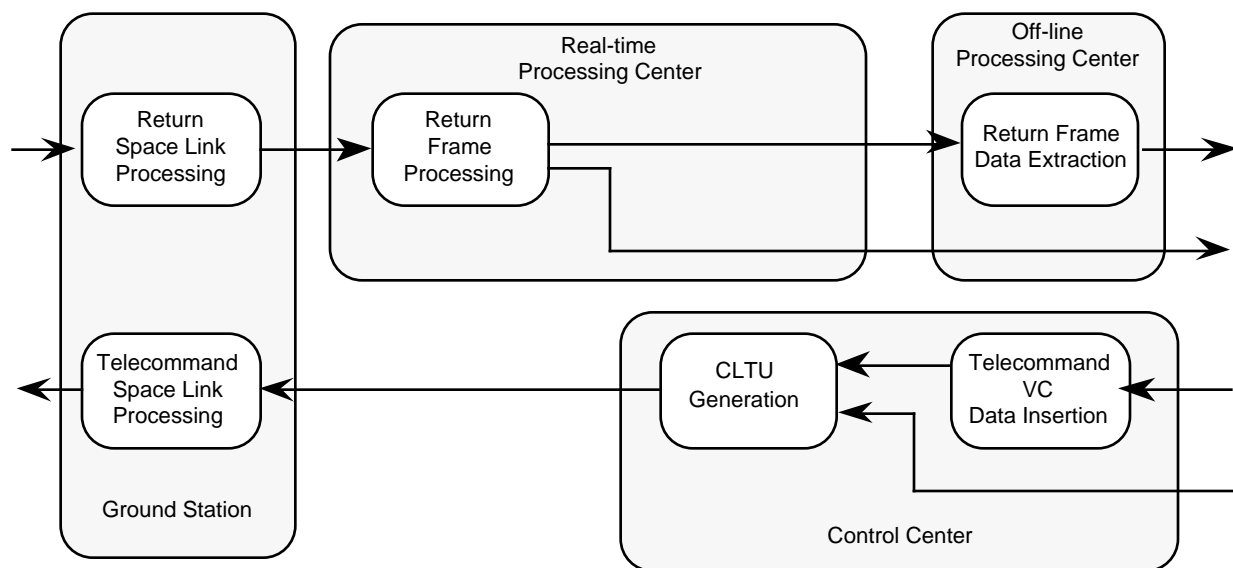
Figure 4-2: Example of Ground Station with Limited Capability

An SLE Complex may contain the complete set of functions required by a mission (in which case the SLE Complex and the SLE System are the same), or a subset of functions. Figure 4-3 is an example of an SLE System comprising two SLE Complexes. In this example, the Ground Terminal SLE Complex implements the Return Space Link Processing and Forward Telecommand Space Link Processing. The Remote Processing SLE Complex implements the Return Frame Processing, Return Data Extraction, CLTU Generation, and Telecommand VC Data Insertion. In this example, the mission uses only the Space Packet and Insert services.
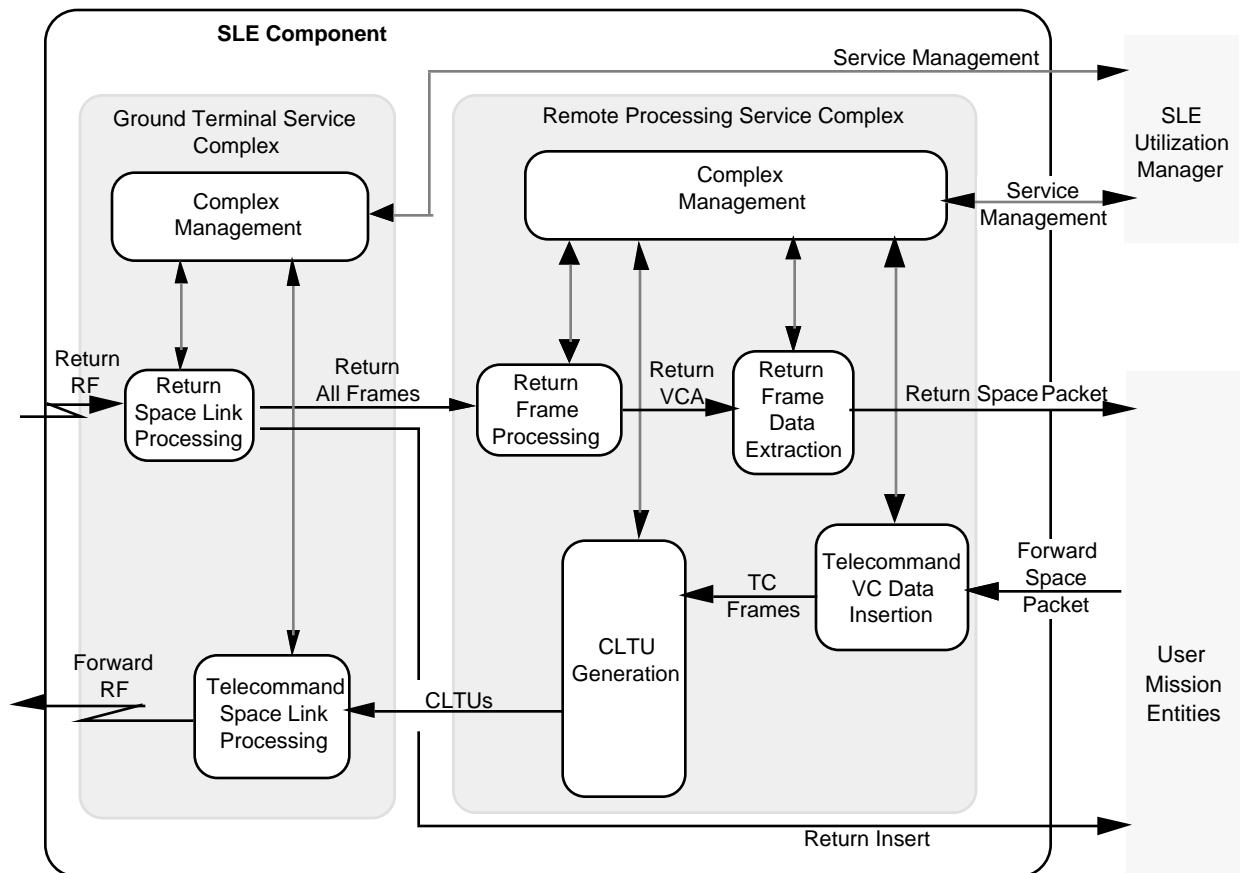
Figure 4-3: SLE System with Two SLE Complexes

4.2   CROSS SUPPORT SCENARIO ILLUSTRATIONS

As already established, different agencies have implemented their systems differently. However, they all must perform common functions. We can describe current agency implementations according to the FGs described earlier in this section.

This subsection provides five scenarios of cross support. These scenarios are generalizations and extensions of actual agency inputs. These scenarios illustrate different functional allocations and different cross support being performed between agencies. The representations of these scenarios verify that the FGs identified earlier are reasonable.

Cross Support Scenario #1, shown in figure 4-4, shows the return link for a situation in which Agency B, which owns the spacecraft, may receive the return data either directly from its own SLE Complex, or from the Complex of another agency.   The return data is processed and individual data units or files of sorted packets are distributed to users and to other agencies. Note that Agency B is distributed among three different Complexes, each having its own Complex Management.
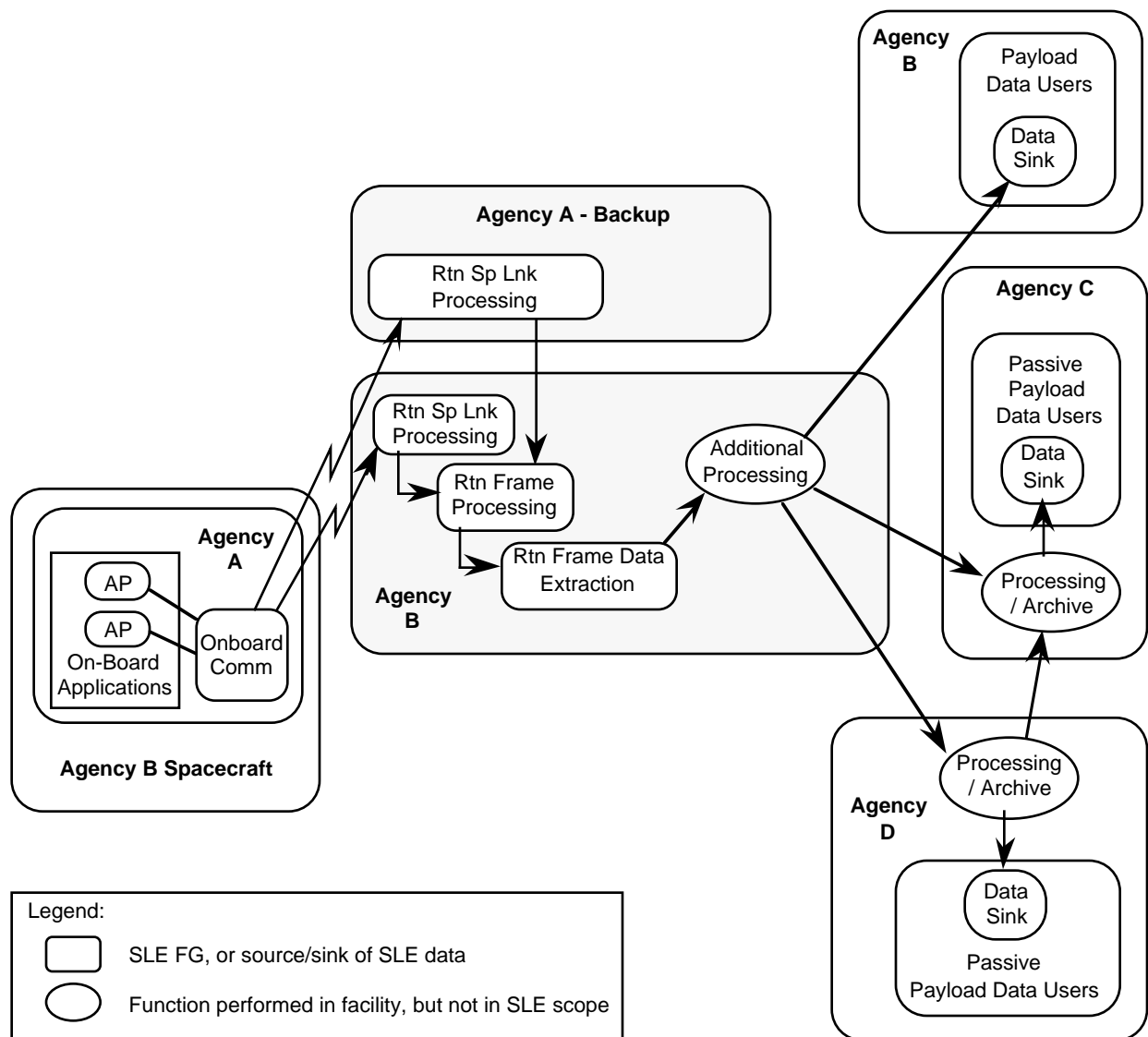
Figure 4-4: Cross Support Scenario #1: Multiple User Agencies

Cross Support Scenario #2, shown in figure 4-5, illustrates the case in which multiple minimal "ground stations" each send all frames received during a pass to a single Complex. This Complex performs all the remaining return processing and distributes the data to users. Similarly, this Complex accepts forward data from users, processes it, and transmits it to the ground stations for transmission to the mission spacecraft.
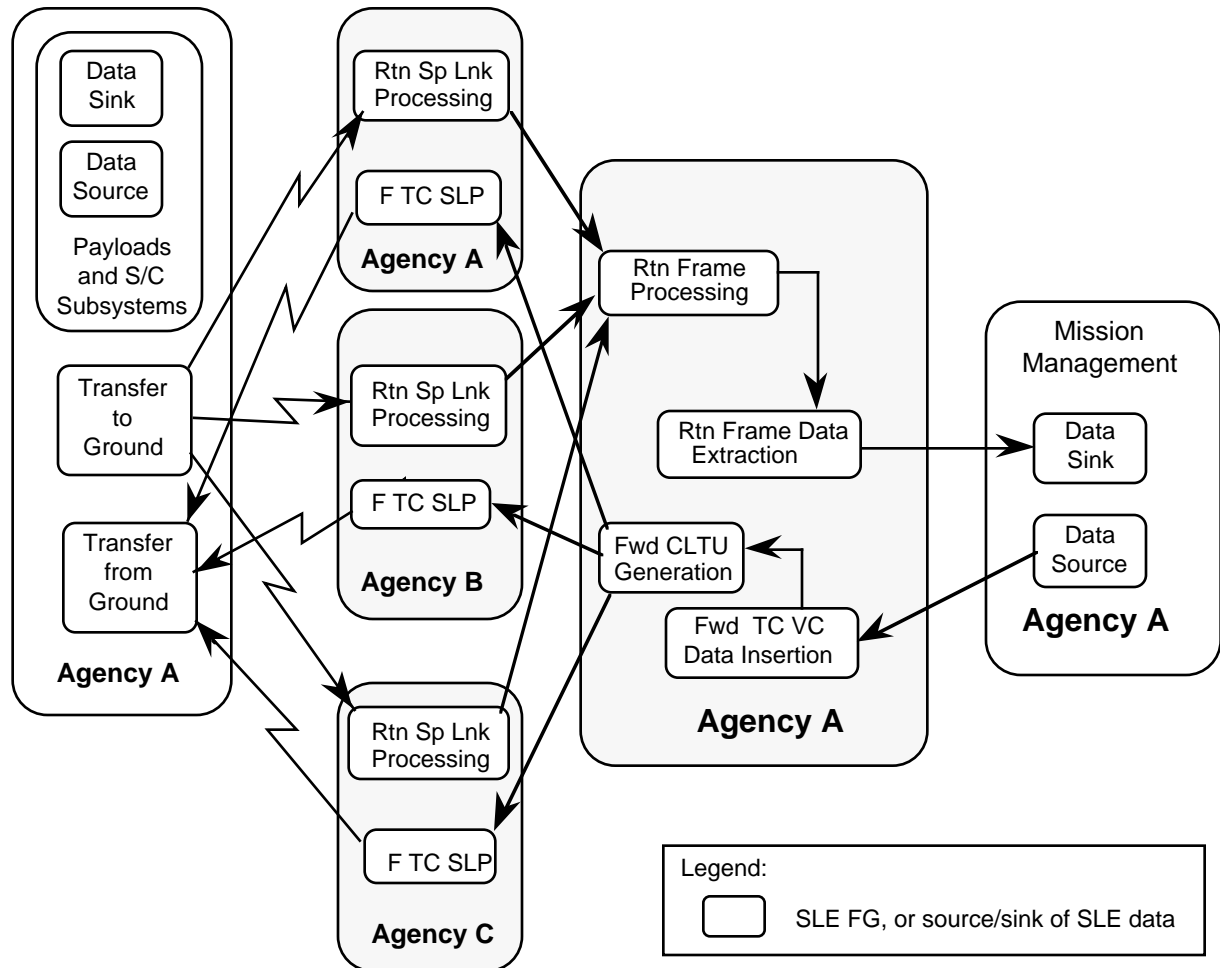
Figure 4-5:   Cross Support Scenario #2: Multiple "Limited Capability" Ground Stations

In Cross Support Scenario #3, shown in figure 4-6, Agency A typically sends data from its spacecraft to a network of ground stations, each of which performs all data processing functions through Return Frame Data Extraction. However, Agency B must utilize two facilities to process the data to this level. While this does not affect the service interface, it may affect the management interfaces between the agencies.
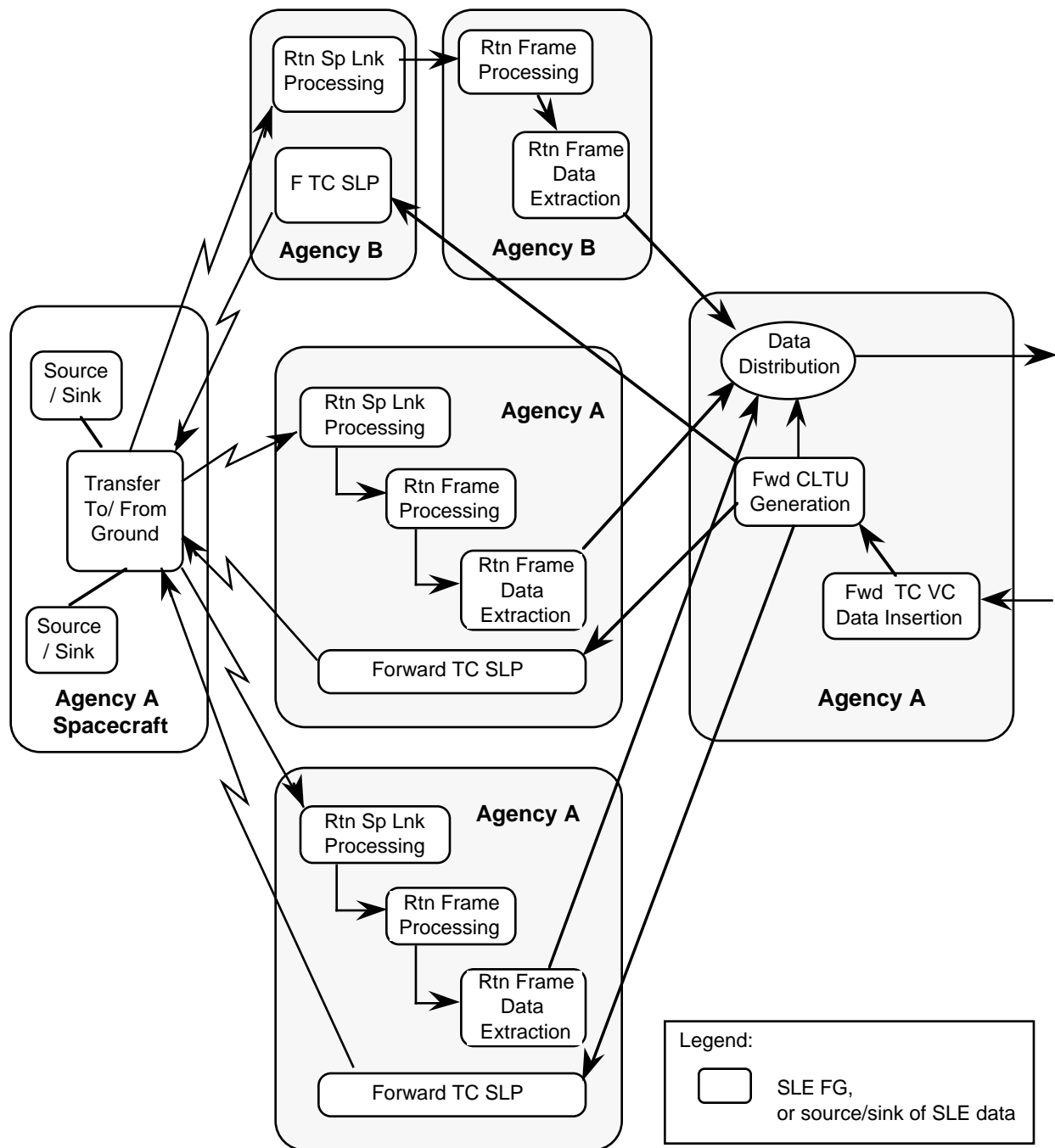
Figure 4-6: Cross Support Scenario #3: "Extensive" and "Limited" Capability Ground Stations

In Cross Support Scenario #4, shown in figure 4-7, Agency B provides a payload on Agency A's spacecraft. Agency A is responsible for receiving the return data and forwarding processed data for the Agency B payload to Agency B, and also for accepting forward data from Agency B and forwarding it to the spacecraft. Agency B plans to develop its own return data processing capability in the future, and will be able to receive the return data directly in the future. Agency A will remain responsible for the forward link.

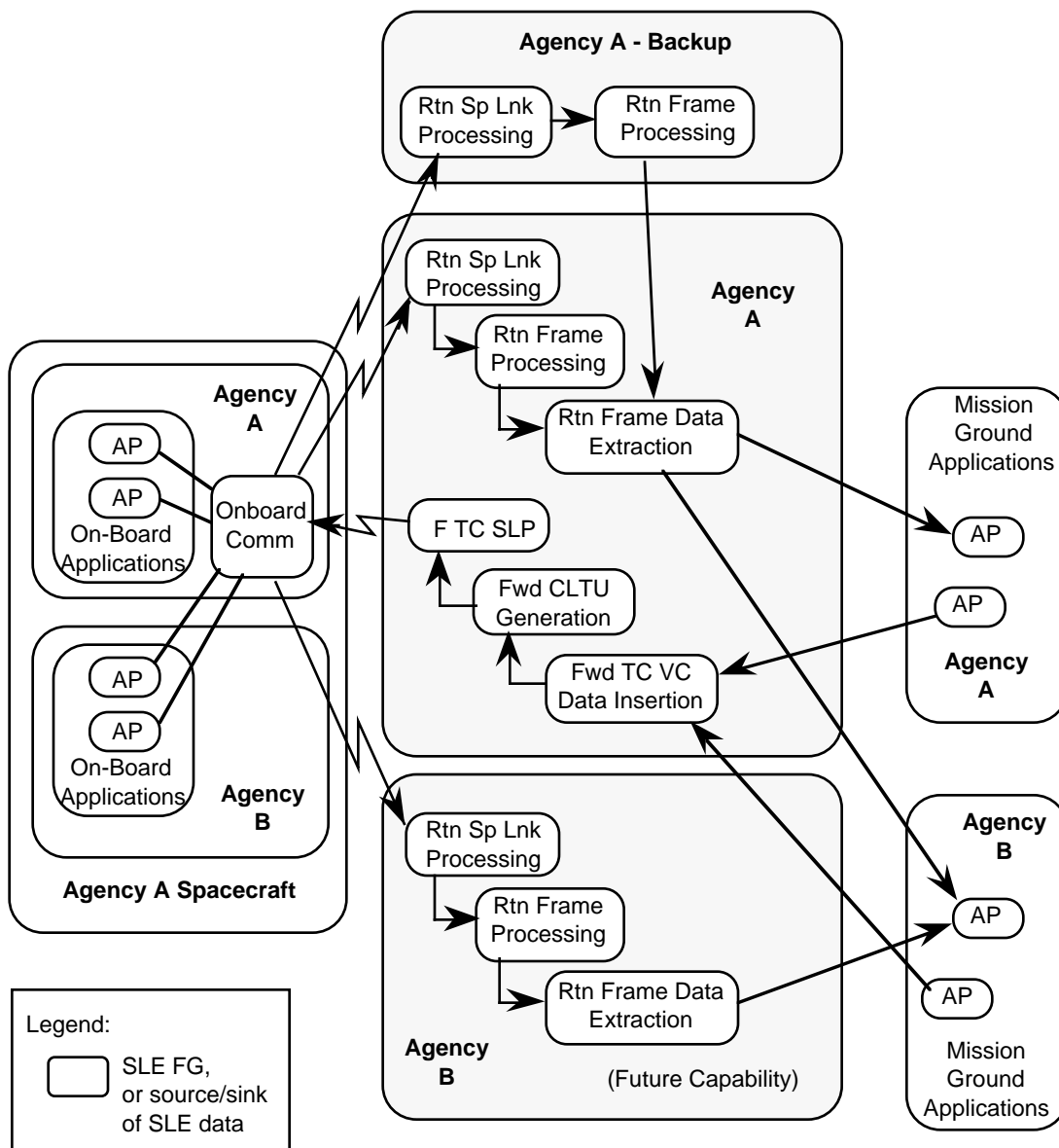**Figure 4-7:** **Cross Support Scenario #4: Multiple "Extensive" Capability Ground Stations**

Cross Support Scenario #5, shown in figure 4-8, illustrates Agency B receiving and processing data from its spacecraft to its users, but only using Agency A for backup.
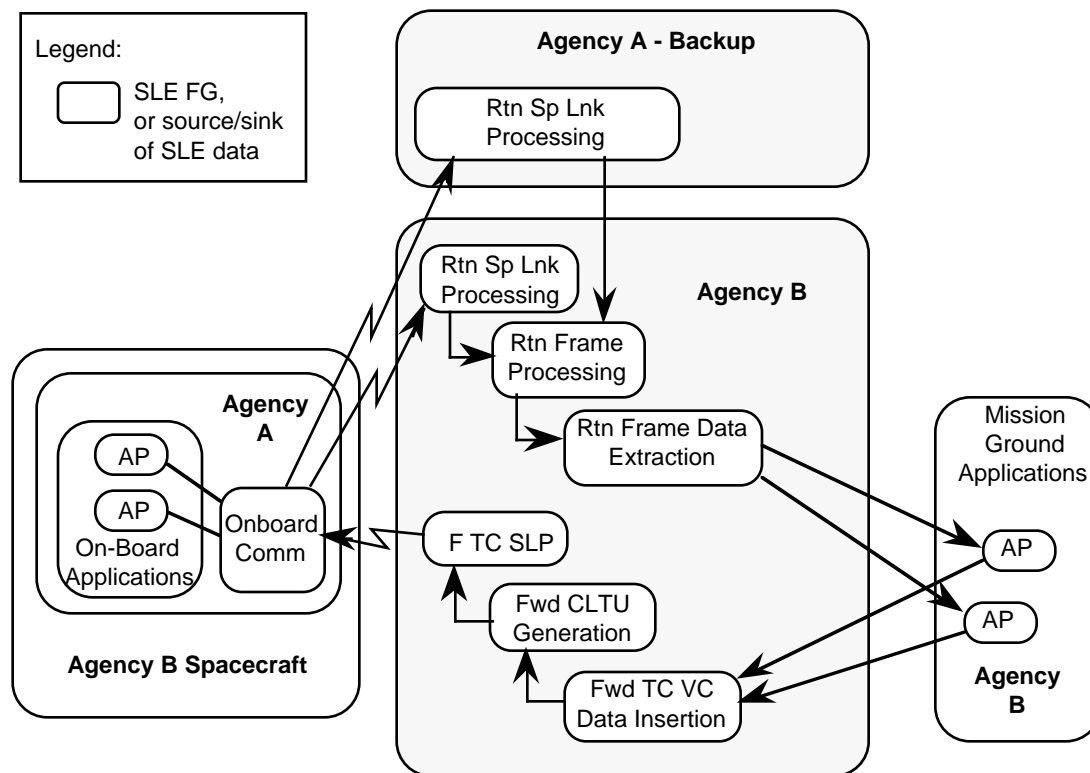
Figure 4-8: Cross Support Scenario #5: Simple Cross Support Backup

5   MANAGEMENT CONCEPT

The SLE Service Management concept is derived from the following goals and objectives.

– The user will be isolated from the details of the individual agency's SLE Systems. The user will interact with the Utilization Manager to provide service characteristics, and not the topology of the system. The user does not need to know how the service is provided, but only how to interface with the service provider. The Utilization Manager negotiates with the involved agencies to identify the characteristics of the service interface.

– A common management representation of services will be provided to users. The common representation applies regardless of the number and combination of services offered by any particular agency. It supports flexibility of an agency to organize internal management domains as it sees fit, while presenting a consistent service view to the user, and it facilitates the ability of agencies to hide system-specific details from users.

– Adequate instrumentation and reporting within the agency's SLE System will be provided to the user. The purpose is to provide sufficient accountability for all services performed by the system. The management concept does not specify SLE Complex-internal management requirements or concepts for management data collection and reporting. It only deals with what information needs to be provided to the mission.

– Automatability will be maximized. As much as possible, the management process should lend itself to automation. The aspects of management that lend themselves to automation are of primary concern.

– The Client's needs to support the mission will be the drivers of the management concept. Management concepts will not be established for the sake of standardization. Rather, concepts will be adopted to support the real needs of the mission activity.

– The costs of implementation will be kept in mind when establishing management concepts. The management concept will be formatted to best minimize costs.

5.1   OVERVIEW OF SLE SERVICE LIFE CYCLE

The life cycle of providing SLE services to a mission is divided into multiple phases. These phases are bounded by the Service Contract, which is the agreement between the agencies that are involved in cross support. An SLE Service Contract is an agreement specifying the SLE Transfer and Management services to be provided to the MDOS by an SLE Complex, and the conditions under which those SLE Transfer services will be provided. This is the macroscopic viewpoint and is referred to as the Service Contract life cycle.

There is only one SLE Service Contract in effect between a particular SLE Complex and a particular mission (represented by an MDOS) at any one time, but there could be more than one SLE Service Contract over the lifetime of the mission. An SLE Transfer Service Instance is the provision of a transfer service for one or more SLE data channels of a given type. Within the SLE Service Contract, the SLE Complex provides SLE Transfer Service Instances grouped into SLE Service Packages. Only SLE Transfer Service Instances of SLE Transfer Services agreed to within the SLE Service Contract may be provided by the SLE Complex during the lifetime of the SLE Service Contract.

The Service Contract life cycle is divided into four phases:

– Agreement;

– Negotiation;

– Implementation;

– Utilization.

Figure 5-1 illustrates the Service Contract life cycle phases. These phases are described below.   The primary phase of interest in this report is the Utilization phase.

Agreement Phase	Negotiation Phase	Implementation Phase	Utilization Phase
Agencies agree to provide cross-support	*Agencies define services and conditions in SLE Service Contract*	*Agencies develop, adapt, or configure systems, if necessary*	*SLE Service Packages are provided/used*

Time
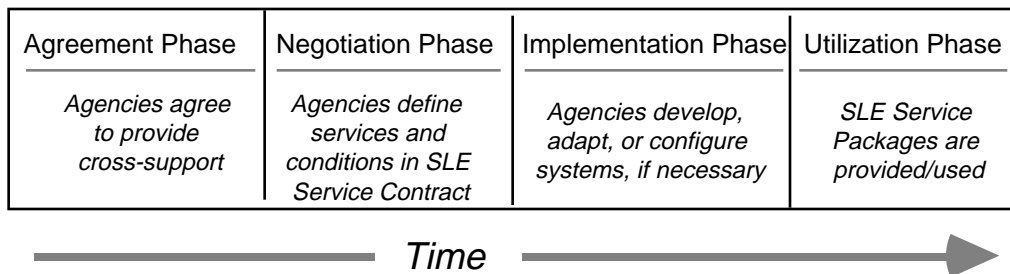
Figure 5-1: SLE Service Contract Life Cycle Phases

The first three Service Contract life-cycle phases are normally performed only once before going on to the next phase. Of course, in certain situations, a phase may be re-executed in order to address outstanding issues. However, the fourth and final phase, called the Utilization phase, has a life cycle of its own. This phase is the microscopic viewpoint and is referred to as the Service Package life cycle because it is based upon individual Service Packages for individual SLE Complexes.

In any particular mission, there will likely be multiple Service Packages for multiple SLE Complexes. They may be executed in succession or be active simultaneously. The Utilization phase is executed separately for each Service Package.

5.1.1 AGREEMENT PHASE

The Agreement phase consists of the early interactions that set the stage for the technical definition of the cross support. It occurs once per mission. The agencies agree on objectives of Service Management interface and legal and financial responsibilities. The organizations responsible for an SLE Complex and an MDOS agree to negotiate an SLE Service Contract. It is not anticipated to be automated via distributed application but through human interaction. The output of the Agreement phase is a Memorandum of Understanding (MOU).

5.1.2 NEGOTIATION PHASE

During the Negotiation phase, the formal terms of the SLE Service Contract are defined. The SLE Service Contract specifies the SLE Transfer services that may be provided by the SLE Complex over the lifetime of the SLE Service Contract, and may set some options and/or option ranges for these SLE Transfer services. The resources that will be accessible and the privileges that will be extended are identified. Inherent in the SLE Service Contract is the range of SLE Transfer services to be provided by the SLE Complex, which of those SLE Transfer services may be provided online and which offline, and whether the SLE Complex is required to store data for offline delivery.

5.1.3 IMPLEMENTATION PHASE

The Implementation phase is the time needed for the SLE Complex to acquire, develop, and configure the resources necessary to satisfy the SLE Service Contract. It might include the development of some new applications. The SLE Complexes perform testing to ensure conformance with CCSDS Recommendations and compatibility with peer processes. The duration of this phase should be short if standard SLE services are incorporated. SLE Service Management is not concerned with this phase.

5.1.4 UTILIZATION PHASE

The Utilization phase is based on the SLE Service Contract that was developed and agreed upon during the Agreement and Negotiation phases. It is the phase during which cross support is available. During the Utilization phase, the SLE Complex provides the SLE Transfer Service Instances pertaining to SLE Service Packages within the constraints of the SLE Service Contract. Certain parameters may be reconfigurable throughout the Utilization phase. A Service Package is a group of Service Instances provided by a single SLE Complex and may involve data that is either online or offline. Service Packages correspond roughly to a Space Link session. As stated above, the Utilization phase is the primary phase of interest for this concept.

The period over which an SLE Service Package is defined, and over which its corresponding SLE Transfer Service Instances are provided, is called the SLE Service Package life cycle. This life cycle has four phases:

- – Preparation;

- – Set-up;

- – Execution;

- – Debrief.

Figure 5-2 shows the SLE Service Package life cycle phases. Note that all of these SLE Service Package life cycle phases occur for each SLE Service Package, and that they all occur within the Utilization phase of the SLE Service Contract.
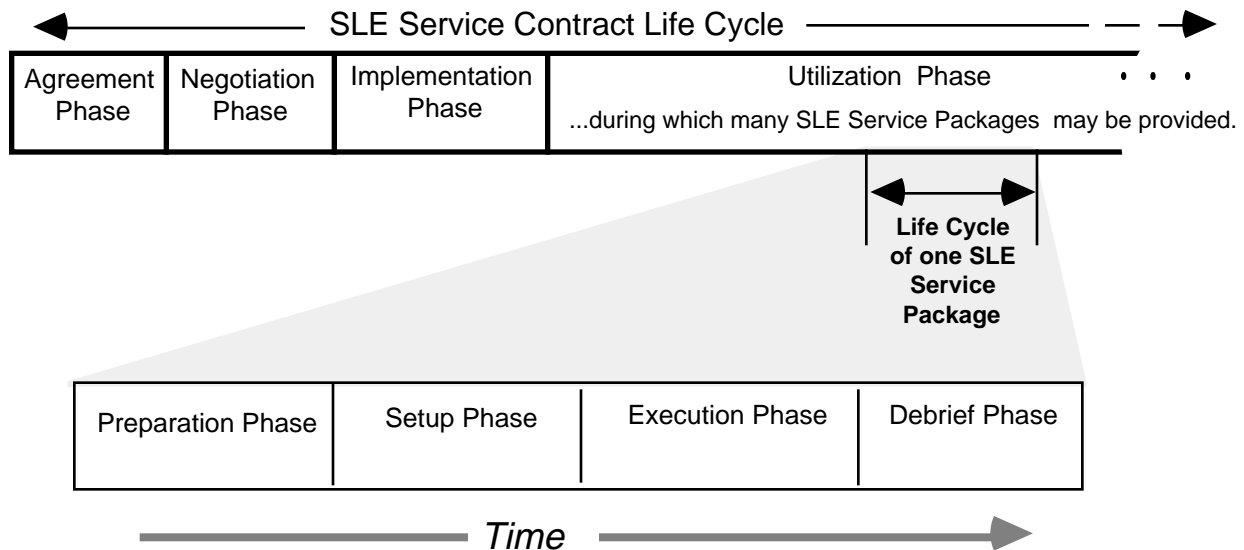
Figure 5-2: Service Package Life Cycle Phases

A Service Package goes through the phases in order. As mentioned above, there may be multiple Service Packages active at a time, and each individual Service Package may be in a different phase. In other words, all active Service Packages are not necessarily in the same phase at any particular time. The following subsections describe the Service Package life cycle phases.

5.1.4.1 SERVICE PACKAGE PREPARATION PHASE

During a Service Package Preparation phase, an SLE Service Package is scheduled at an SLE Complex by the SLE Utilization Manager of an MDOS. Parameter values are selected for all parameters within bounds of service specified during the Negotiation phase and any schedule information applicable to a particular upcoming Execution phase. Schedule information includes items such as start of service and duration of service. Negotiation of schedules is also performed during this phase of the Service Package life cycle. These actions are performed for each service that will be required during the upcoming Service Package Execution phase.

5.1.4.2 SERVICE PACKAGE SETUP PHASE

During the Service Package Setup phase all necessary actions are taken by the SLE Complex to ensure that SLE Service Instances listed in the SLE Service Schedule can actually be provided during the upcoming SLE Service Package Execution phase. These actions may include initiation of a service, testing of service interfaces, and refinement of service parameters. With the exception of interface testing, actions that take place during the Service Package Setup phase are internal to an SLE Complex.

5.1.4.3 SERVICE PACKAGE EXECUTION PHASE

During a Service Package Execution phase various interactions may take place between SLE Complexes and between an SLE Complex and a user. Interactions may concern the exchange of space data or the delivery of event, alarm, and status reports. An SLE Service Session is the period of time during which an SLE service is provided. The execution phase is the period during which an SLE Service Session exists. In the SLE Service Package Execution phase, SLE Transfer Service Instances are provided by the SLE Complex according to the SLE Service Schedule. The provision of the SLE Transfer Service Instances to the mission user entities is controlled through control operations invoked by the mission user entity and through management operations invoked by the SLE Utilization Management.

5.1.4.4 SERVICE PACKAGE DEBRIEF PHASE

During a Service Package Debrief phase accounting information regarding the SLE Execution phase is delivered to SLE Utilization Management and/or the service user. A Debrief Report is provided to the user at the end of this phase. Agencies are expected to provide the Debrief Report; however, the degree of standardization will be determined at a later date.

5.2 SERVICE MANAGEMENT APPROACH

This subsection presents the approach to managing SLE services. In particular, it considers the management of the SLE Service Packages. It is covered at a very high level of detail. The SLE Service Package Management Recommendation will provide the detailed description.

5.2.1 MANAGEMENT BY SLE COMPLEX

SLE Service Management is distributed between SLE Complex(es) and the mission. The Service Management component of an SLE Complex is called Complex Management. The Service Management component of a mission is called Utilization Management. Service Management is accomplished through the management of the functions performed by the individual SLE Complexes (i.e., Complex Management) that provide the Service Packages. Service Management is defined in terms of what the SLE Complex does on behalf of, and

from the perspective of, Utilization Management. Execution of Service Management relies on the performance of management functions within the SLE Complex. The SLE Complex-internal management functions are hidden from the external view provided to Utilization Management.

Figure 5-3 illustrates the Service Management components and interfaces. Complex Management has SLE Complex-internal interfaces with Service FGs to enable management data collection. Complex Management provides the management information to Utilization Management.
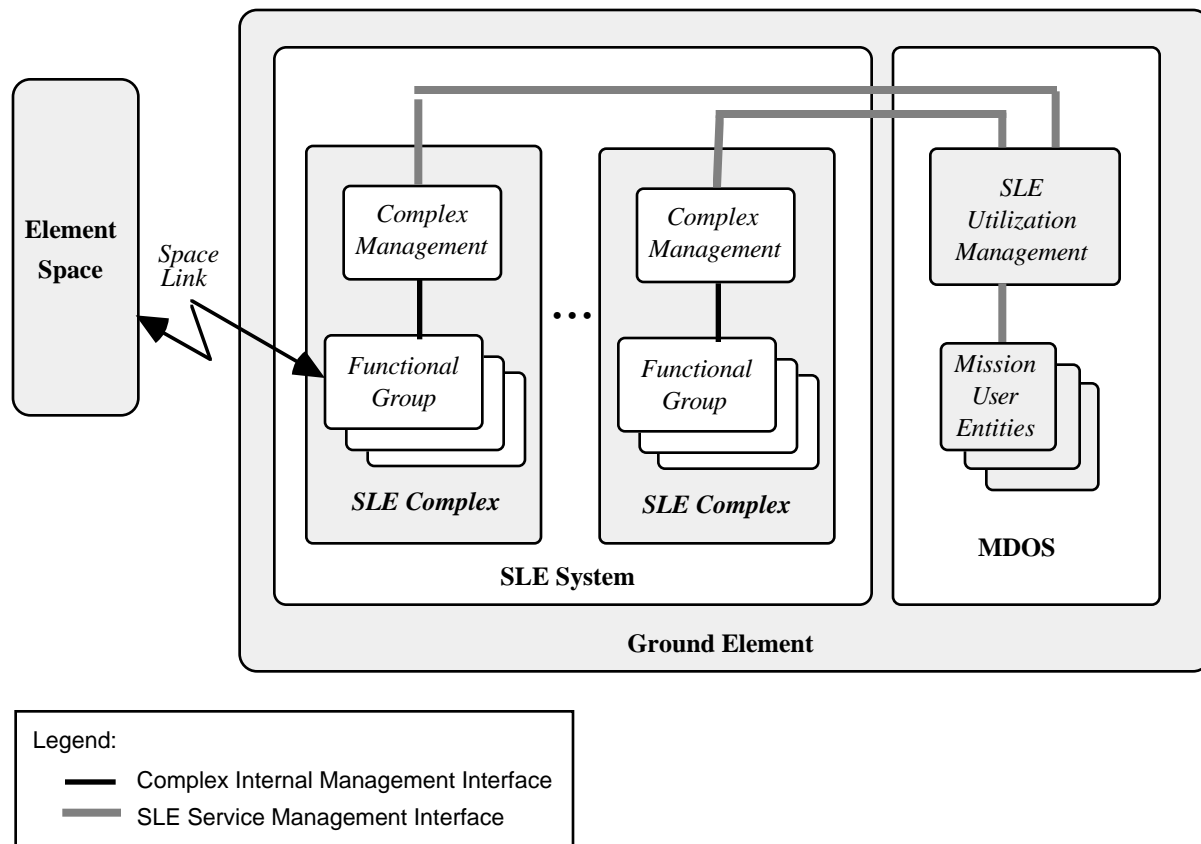
Figure 5-3: Service Management Components and Interfaces

The role of Utilization Management is as follows:

– Utilization Management needs to coordinate service parameters such as frame length, error coding used;

– Utilization Management must coordinate the service connection mechanism between SLE Complexes and between SLE Complexes and users;

– Utilization Management needs to monitor service performance indicators such as R-S correction rates, partial packet counts, active data rates, counts of Space Link data received, effective throughput, and counts of Space Link data sent.

5.2.2   SERVICE CONTROL BY USER

Because service support affects multiple users, Service Management must coordinate and resolve conflict among multiple service users. Service control by the user affects only the service directly consumed by the user. The user may control data exchange rates and data buffering characteristics with the service supplier but does not (must not) affect underlying services or handling of SL protocols.

Service control by the user is via a direct connection with the SLE Complex supplying the service. This is more efficient and timely than going through Utilization Management to affect and/or monitor service performance. The user can correlate status changes provided through a service control mechanism with the service data stream because the status change occurs within the same time frame. For example, a "lost synchronization on data channel" message sent to the user on a control channel will be provided with approximately the same delay as Space Link data on the Space Data Channel. Therefore, the user will know how to interpret what is being received on the Space Data Channel in a timely manner. Relying on the Service Management mechanism, which is not synchronized with the service data stream, will introduce more delay, and the delay through Complex Management and Utilization Management will have a greater variance with respect to the event in the data stream. Carrying status information as annotation fields in Space Link data is another approach that works well when status changes occur frequently, but is a waste of bandwidth if the status does not change frequently.

5.3   SERVICE MANAGEMENT FUNCTIONAL AREAS

The OSI has identified five Service Management Functional Areas. SLE Service Management incorporates the OSI categories, and the corresponding definitions are assumed except as noted. They are:

– Service Configuration Management;

– Service Accounting Management;

– Service Fault Management;

– Service Security Management;

– Performance Management.

NOTE – The OSI functional area of Performance Management is considered to be an SLE Complex-internal function and is not included in SLE Service Management. Performance Management Information is not reported by an SLE Complex Manager to the Utilization Manager.

5.3.1   SERVICE CONFIGURATION MANAGEMENT

Service Configuration Management collects configuration data and provides it to the service user. Service Configuration Management supports the authentication/authorization process by providing the following:

– permission to request or receive a service; and

– details of exact agreed-upon service features to be made available.

Service Configuration Management also supports the user by establishing default configurations and configuring dynamic configurations as applicable. In this context, halting and restarting services may be necessary to allow configuration changes to be performed.

Utilization Management provides configuration data to the service user. Utilization Management informs Configuration Management of operational parameters for services. Complex Management sets parameters within the SLE Complex to control operation. Complex Management collects status information and reports it to Utilization Management.

It is expected that agencies provide configuration management; however, configuration management is not expected to be standardized.

5.3.2   SERVICE ACCOUNTING MANAGEMENT

SLE Service Accounting Management is oriented toward accounting for data related to the service agreement (i.e., accountability). Input, output, and protocol processing statistics allow Utilization Management to assess "contractual" performance of SLE Complexes.

Complex Management provides Utilization Management with an accounting of the data that is received by, the data that is sent from, and the data that is processed by that particular SLE Complex during a session. Accounting is provided for both the return data and for forward data.   In both directions, accounting occurs on intermediate Space Link data.

Service Accounting Management provides the service user with a post-session summary report.

5.3.3   SERVICE FAULT MANAGEMENT

Service Fault Management consists of management and monitoring of abnormal operations. It is responsible for maintaining error logs, locating and isolating faults, responding to error notifications, supporting diagnostic tests to identify types of faults, and correction of faults.

Service Fault Management provides Utilization Management with notification that faulty conditions exist within the SLE Complex that affect services being provided (and identifies the affected services), and provides estimated return to service. Actual fault detection, isolation, and correction within the SLE Complex is an internal fault-management activity that is not exposed to Utilization Management other than to identify impacts on services.

Service Fault Management provides Utilization Management with during-the-session input, output, and protocol processing statistics to assist in end-to-end fault detection and isolation between SLE Complexes.

SL protocol-processing statistics reported by Service Fault Management to Utilization Management provide additional information on Space Link quality indication (e.g., R-S correction rate) and indication of possible faults in an onboard data system (e.g., systematic discrepancy between packet length field and frame first header pointer). Candidate service fault management reporting mechanisms include periodic reports, event reports, and polled reports.

5.3.4   SERVICE SECURITY MANAGEMENT

Service Security Management will concern itself with protecting access to cross-support services by providing functions such as:

–   administration of passwords allowing users from one agency to log into the system of another;

–   administration of access to interfaces, e.g., access on the basis of application process identifications to and from the user application;

–   command authentication on the forward link; and

–   authentication of requests for offline data.

The provision of encryption and decryption of data in packets is considered to be the responsibility of the owners of the packet and therefore is considered to be out of scope for CCSDS.

The level of security required by a particular mission will be negotiated in the SLE Service Contract by the Utilization Management and the Complex Management.

During the execution of the SLE Service Contract, the Service Security Management will maintain security logs and provide agreed-upon security information to Utilization Management.

ANNEX A

CROSS SUPPORT CONCEPT TERMINOLOGY

Agreement phase	During the Agreement phase the agencies agree on the objectives of the service managerial interfaces, legal and financial responsibilities, etc. This phase is not anticipated to be automated; rather, this phase will be implemented through human interactions.
annotation	The extension of the Space Link services requires that information be added to the SL data units. The process of adding information to the Space Link data is called annotation.
cross support	The term cross support is applied when one agency uses part of another agency's data-system resources to complement its own system.
Debrief phase	During the Debrief phase, accounting and performance information about the Execution phase is delivered to the Service Manager and/or to the service user.
Execution phase	During the Execution phase, various interactions may take place between the agencies. Interactions may concern the exchange of space data or the delivery of event, alarm, and status reports.
forward data	Forward data is all data that is sent from the ground element to the space element (e.g., telecommand).
Functional Group	The Functional Group (FG) is the fundamental building block of an SLE service; it is not decomposed further. FGs are derived from the layered functionality specified in the Space Link protocols.
ground element	The ground element is the collection of systems and organizations based on the ground that provide SLE services used by a specified mission.
Implementation phase	The Implementation phase is the time allowed for the SLE Complex to acquire, develop, and configure the resources necessary to satisfy the SLE Service Contract. This phase includes any testing necessary to ensure conformance of the implementation with the appropriate CCSDS standards and compatibility between peer processes.
mission	For the purposes of this Report, a mission is an undertaking to explore/utilize fields of interest by use of one or more spacecraft.

mission data	Mission data comprises spacecraft, instrument, and other data for a specific mission. It includes spacecraft forward and return data in raw and processed form.
Mission Management	Mission Management is the function within the mission ground segment that is responsible for the management of the mission. It identifies and defines the detailed objectives of a mission considering the conflicting requirements of payload users, the spacecraft, and the resources available to the mission.
Negotiation phase	During the Negotiation phase, the cross-support agencies develop the SLE Service Contract for the mission. This phase is not anticipated to be automated via a distributed application; rather, this phase will probably be implemented through human interactions.
online	For the purposes of this Report, online refers to the transfer of SLE service data through all or part of the SLE System during the time that the associated space link session is active.
offline	For the purposes of this Report, offline refers to the transfer of SLE service data through all or part of the SLE System at a time other than that during which the associated space link session is active.
Operations phase	In the Operations phase, the user defines support requests that are sent to the Provider Agency, which in turn responds by establishing the support in the form of a schedule. If the support cannot be scheduled, the fact is communicated to the user, who can in turn formulate new Support Requests.
payload	The Payload is the equipment, carried on board the spacecraft, that directly relates to the purpose of the flight.
Preparation phase	During the Preparation phase, parameter values are selected for all parameters within the bounds of service specified during the Negotiation phase and any schedule information applicable to a particular Execution phase.
return data	For the purposes of this Report, return data is all data that is sent from the space element to the ground element (e.g., telemetry).
Schedule	For the purposes of this Report, a Schedule is a chronological list or timeline of spacecraft activities and allocated resources constituting the daily operations plan for mission support.
Scheduling	For the purposes of this Report, scheduling is the task of placing activities onto a timeline and allocating resources.

Setup phase	During the Setup phase, all necessary actions are taken to ensure that the service selected during the preparation phase can actually be provided during the Execution phase.
SLE Complex	The functions that perform SLE System services can be distributed across multiple systems. This distribution is aligned with the layering of the Space Link services. The systems performing individual functions of a service may belong to different organizations and have varying size and structure. The systems performing SLE service are grouped into SLE Complexes by the organizations that implement them. Each SLE Complex has two components, a Service Provision component and a management component.
SLE Complex Manager	The SLE Complex Manager is the component of an SLE Complex which manages space data transfer.
SLE Service Contract	The Service Contract is the agreement between the agencies that are engaged in cross support. The SLE Service Contract defines the set of Service Packages that are to be supported over the lifetime of the SLE Service Contract. The resources that will be accessible and the privileges that will be extended are identified.
SLE Service Instance	An SLE Transfer Service Instance is the provision by an SLE Complex of the capability to transfer one or more SLE data channels of a given type, all of which are related to the same Space Link Session.
SLE Service Package	An SLE Service Package is the set of instances of SLE Transfer Services, together with the specification of the characteristics of the production of those SLE Service Instances, that are provided by one SLE Complex to one or more SLE Transfer Service users, with respect to one Space Link Session.
SLE Service Session	An SLE Service Session is the connection between an SLE service user and an SLE service provider over which an SLE service is utilized.
SLE service category	An SLE service category is one of the following: return SLE services, forward AOS SLE services, or forward telecommand SLE services.
SLE System	An SLE System comprises the global collection of systems and organizations that provide SLE services.

Space Data Channel	For the purposes of this Report, a Space Data Channel is a virtual stream of Space Link data units of the same type, with a single unique identification.
space element	The space element comprises the collection of systems and organizations, based on board the spacecraft, that provide SLE services used by a specified mission.
Space Link Extension service	Space Link Extension (SLE) service is the set of services that extend one of the CCSDS SLS services, providing access to the ground termination of that service from a remote ground-based system. An SLE service supplies or consumes one or more channels of the same Space Data Channel type.
Space Link service	The Space Link service is the service provided over the SLS to the user during a contact with the spacecraft.
user	For the purposes of this Report, a user is an entity receiving services.
Utilization Manager	The component of Mission Management responsible for SLE services is called Utilization Management. Service Management is accomplished through the management of the functions performed by the individual SLE Complexes that provide the SLE services.

ANNEX B

CROSS SUPPORT CONCEPT ACRONYMS

This Annex identifies and defines the acronyms that have been adopted in this Cross Support Concept Report.

AOS	Advanced Orbiting System
APID	Application Identification
CLTU	Command Link Transmission Unit
FG	Functional Group
FSH	Frame Secondary Header
MC	Master Channel
MCID	Master Channel Identification
MDOS	Mission Data Operation System
MOU	Memorandum of Understanding
OCC	Operations Control Center
OCF	Operation Control Field
SCID	Spacecraft Identification
SL	Space Link
SLE	Space Link Extension
SLS	Space Link Subnet(work)
TC	Telecommand
TF	Transfer Frame
VC	Virtual Channel
VCA	Virtual Channel Access
VCDU	Virtual Channel Data Unit
VCID	Virtual Channel Identification